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(54) SYSTEM FOR PROJECTING IMAGES

(71) We, SOCIETE FRANCAISE D'EQUIPEMENTS POUR LA NAVIGATION AERIENNE, a Societe anonyme organised and existing under the laws of France, of Aerodrome de Villacoublay, 78140 Velizy Villacoublay, France, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to a system for projecting images.

In our Patent No. 1,551,135 there is described and claimed a system for projecting images representative of information on a screen comprising a converter for transforming said information into luminous digital signals emitted by a succession of light sources, an arrangement of bundles of optic fibres in which the receiving ends of each of the bundles are illuminated by a respective said light source, a member constituted by an arrangement of the emitting ends of the optic fibres for forming an image representative of said information, and a lens which projects said image onto the screen.

The purpose of such a system is that it can be used to provide the pilot of a vehicle with information relating to the driving or piloting of the vehicle and this is without the pilot having to interrupt his external vision.

In the case where the vehicle is an aerodyne, this information may advantageously consist of the normal data coming from a flight-control device or an indicator for guiding the aerodyne on the runway or in flight.

An object of the present invention is to improve the transfer and formation of the images on the screen so as to obtain better definition of the images and facilitate the juxtaposition of several images.

According to the present invention there is provided a system for projecting images representative of information on a screen comprising a converter for transforming said information into luminous digital signals emitted by a succession of light sources, an arrangement of bundles of optic fibres in which the receiving ends of each of the bundles are illuminated by a respective said light source, a member constituted by an arrangement of the emitting ends of the optic fibres for forming an image representative of said information, and a lens which projects said image onto the screen, characterised in that the fibres are combed and arranged parallel to each other, and the emitting ends of the bundles of optic fibres are rectangular in section.

The system can comprise a plurality of members for forming images, and the members are associated with an optical mixer comprising as many channels as there are members for forming images.

If desired the system can have a plurality of mixers having a limited number of channels in series.

The mixers having a limited number of channels can comprise mixers with two channels provided by means of semi-reflecting mirrors or dichroic reflectors.

The invention will now be further described, by way of example, with reference to the accompanying drawings in which:

Figure 1 shows an arrangement of the optic fibres in a system formed according to the invention in the region of the member for forming images in an object focal plane of the lens;

Figure 2 shows an arrangement for illuminating the receiving ends of the optic fibres;

Figure 3 shows diagrammatically an optical mixer using a succession of mixers comprising the two channels in series;

Figure 4 is a block diagram of a system for controlling the member for forming images

from data provided by a calculator;

Figure 5 is a diagrammatic partial longitudinal section of a front part of a cabin of an aircraft provided with a system formed according to the invention comprising a device for increasing the dimensions of the image projected on the windscreen of the aircraft;

Figure 6 is a diagrammatic illustration of the final image obtained by the juxtaposition of two images coming from the same initial beam;

Figure 7 is a diagrammatic partial longitudinal section of a front part of a cabin of an aircraft provided with a system formed according to the invention for a curved windscreen;

Figure 8 is a partial diagrammatic section on line A-A of Figure 7, this section showing the nature of the correction obtained by a correcting device constituted by a cylindrical lens, in a plane at right-angles to the generatrices of that lens;

Figure 9 is a simplified diagram showing the optical path of light rays from the lens in a system formed according to the invention;

Figures 10 and *11* are optical diagrams demonstrating problems which the invention intends to solve, and

Figure 12 is a partial diagrammatic section of an aircraft cabin showing a preferred position of an outlet component of the lens in a system formed according to the invention in the plane of an upper part of the dashboard in the cabin.

Referring to Figures 1 and 2, the transfer member consists of a plurality of bundles of optic fibres each bundle comprising a plurality of sub-assemblies, each sub-assembly comprising a plurality of optic fibres. A receiving end of each bundle is associated with at least one controllable light source. A member for forming an image is constituted by an arrangement of the emitting ends of the optic fibres corresponding to the image which it is desired to obtain.

The emitting ends of the optic fibres are arranged so that the ends of the sub-assemblies have a geometric shape which can be produced easily and accurately.

The most basic shape is rectangular, and Figure 1 shows how a rectangular configuration facilitates the juxtaposition of several images in the object focal plane of the lens, for example a horizontal image 10 and three vertical images 11, 12 and 13.

In order to obtain good luminous homogeneity of the objects projected, the luminous fibres of each of the bundles are combed to make them parallel to each other at their emission and reception ends. Maximum reception is achieved when the terminal cross section of each of the fibres is at right-angles to the light rays.

The light signal transmitted to each of the sub-assemblies of optic fibres may be generated by a separate light source.

These light sources consist for example, as shown in Figure 2, of micro bulbs 15 housed in recesses 16, in the region of which the receiving ends of the optic fibres 17 of the corresponding sub-assemblies are arranged.

In the example shown in Figure 1, the formation of images was obtained by juxtaposition of the various arrangements of optic fibres 14 in the member for forming images.

This result could also be obtained by mixing several separate images.

Mixing may be by means of a conventional optic mixer of the type currently used in colour televisions for example.

Mixing may also be by connecting several mixers having two inputs 18 and 19 in series (Figure 3).

Where one wishes to provide a member for forming overlapping images by the light sources and corresponding arrangements being allocated to several objects, the problem is that of controlling the light sources and of multiplexing in the transmission of the control signals.

To this end, the control of each of the light sources may take place by assigning a binary number serving as an address to each light source, and a switching circuit causes the illumination of this light source, when it receives the corresponding address.

Where one wishes to generate a single movable object, representative of a variable magnitude, the connection between the calculator and the de-coding member producing the control of the light sources takes place by a bus comprising a number of connections equal to the number of bits used in the binary addressing numbers.

If it is necessary to generate several moving objects representative of different magnitudes, simultaneously, the problem becomes much more complex.

This problem is solved by using the well-known properties of retinal persistence: instead of transmitting the addresses simultaneously to the switching circuit effecting control of the light sources, the addresses are transmitted successively at a frequency such that, due to retinal persistance (as well as the inertia of the light sources) the switching cannot be discerned.

With reference to Figure 4, the calculator 21 transmits separately the digital signals corresponding to several objects (a), (b), (c), (n) to a selector 22 which successively transmits these signals to a transmission line 23 with limited conductors, which is connected to a de-coder 24 controlling the illumination of the light sources.

It should be noted that the multiplexing system could be applied, in a similar man-

ner, to a member for forming an image produced by means of an arrangement of liquid crystals. fulfilling the function of electrically controlled shutters.

In the display system illustrated in Figure 5, which is located in the dashboard 31, below the windscreeen of the aircraft, only lens 32 and a device to increase the dimensions of the image projected onto the windscreen 33 have been shown. Lens 32 is a conventional lens making it possible to collimate at infinity as described in Patent 1551135 the emitting face of member 34 for forming the image.

The beam 35 having parallel rays emitted by the lens is directed towards two parallel plane mirrors 36, 37 arranged one after the other. The beam 35 successively undergoes partial reflection on the semi-reflecting mirror 36 and complete reflection on the total reflection mirror 37, for the part of the beam transmitted through the mirror 36.

The position of the two mirrors 36 and 37 and their dimensions are such that they are completely contained in the field of the lens 32 and such that the two beams 38 and 39 successively reflected are adjacent one another in order to obtain two juxtaposed images on the windscreen 33 of the aircraft.

Examples of such images are the images 41 and 42 or 43 and 44 shown in Figure 6 (the images 43 and 44 being shown to indicate the possible direction of movement of the image in the field of the optical system). In this Figure 6, the rectangles 45 and 46 represent the field of the optical systems constituted by the lens 32 and the two respective mirrors 36 and 37.

It is obvious that in order that there is superimposition of the two fields and images 41, 42 and 43, 44, it is firstly necessary that the image moves from one side of the field to the other and that secondly, the upper and lower edges 47 and 48 respectively of the image are equal so the lower edge 48 of the image 41 can be juxtaposed with the upper edge 47' of the image 42.

Furthermore, to obtain good homogeneity of the image, a semi-reflecting mirror 36 is chosen so that the transmitted intensity is slightly greater than the reflected intensity.

Naturally, the number of semi-reflecting mirrors and consequently the number of juxtaposed images are not limited to two. By means of a substantially punctuate image for example, it is possible to obtain an image having a linear appearance.

With reference to Figure 7, the optical system 53 provided in the dashboard 51 located below the windscreeen 52 of the aircraft comprises a cylindrical lens 58 in addition to the conventional lenses illustrated by the components 54, 55, 56.

Lens 58 which is located between the components 54, 55, 56 and the member 57 for forming images, modifies the light rays emanating from the member 57, such that instead of obtaining a light beam having parallel rays at the outlet of the components 54, 55, 56, one obtains a slightly divergent beam 59. After reflection on the windscreen 52, beam 59 is transformed into a beam 60 having parallel rays, the shape of the lens 58 having compensated for the angular deviation which would have occurred due to the shape of the windscreen 52.

Due to the fact that a cylindrical lens 58 is used, the correction takes place solely in planes at right-angles to the generatrices of the lens. In planes parallel to the axis or containing one of the generatrices of the lens 58 (Figure 8), there is no correction for the shape of the windscreen 52. However, for numerous applications, this does not matter. For example, where the display and indication system serves as a head-up flight control device, for example for guiding the aircraft on the ground and where the image visible on the windscreen is constituted by a vertical bar moving horizontally, it is obvious that the correction only takes into account the horizontal profile of the windscreen 2; a correction taking into account the vertical profile would prove useless.

In the previously described systems, the optical part is integrated in the restricted space free behind the pilot's instrument panel.

For reasons of bulk the light ray has firstly been made to follow a twisting path, by means of reflecting mirrors, between the member for forming images and the vehicle windscreen.

These systems have as a drawback that the pilot can see all the objects projected onto the windscreeen only if he is located in the axis of the rays reflected by the windscreen.

It has been found that this drawback was due mainly to the length of the optical path between the plane of the part of the lense fulfilling the role of a diaphragm (or iris) and the windscreen of the vehicle.

This drawback is eliminated by reducing the use of reflectors, as shown in the optical system such as that illustrated in Figure 9.

The convergent lens has been shown diagrammatically, the axis 62, after reflection on the windscreen 64, merges with the axis 63 of the pilot's field of vision (eye 0). This optical system therefore behaves in the same manner as a conventional clear collimation system.

The object images 65 provided by the member for forming images are formed at infinity and can be seen by the pilot without him having to interrupt his external vision.

The field AB of the optical system is limited solely by the dimensions of the lens L_1, which, arranged virtually at right-angles

to the axis 63, behaves in the manner of a diaphragm L'_1.

If the pilot moves towards the windscreen (eye 0'), his field of vision A'B', within the optical system, increases considerably.

Furthermore, as regards Figures 10 and 11, if one looks at an object through a diaphragm L", the closer the eye 0 to the object, then the larger the angle (deviation Δ. Δ'), for which one can see all the object through the diaphragm.

Consequently, as it is not possible in practice for the pilot to move further towards the windscreeen, it is therefore appropriate to move the diaphragm L'_1 essentially nearer to the pilot's eye. This can be done by moving the lens as close as possible to the windscreeen.

Consequently, as shown in Figure 12, the outlet component 66 of the lens 67 is located in the plane of the upper side of the dashboard 68 of the pilot's cabin as the to dashboard 68 is the lower limit of the pilot's normal field of vision towards the front.

WHAT WE CLAIM IS:-

1. A system for projecting images representative of information on a screen comprising a converter for transforming said information into luminous digital signals emitted by a succession of light sources, an arrangement of bundles of optic fibres in which the receiving ends of each of the bundles are illuminated by a respective said light source, a member constituted by an arrangement of the emitting ends of the optic fibres for forming an image representative of said information, and a lens which projects said image onto the screen, characterised in that the fibres are combed and arranged parallel to each other, and the emitting ends of the bundles of optic fibres are rectangular in section.

2. A system as claimed in claim 1, in which the system comprises a plurality of members for forming images, and the members are associated with an optical mixer comprising as many channels as there are members for forming images.

3. A system as claimed in claim 1 or claim 2, further comprising a plurality of mixers having a limited number of channels in series.

4. A system as claimed in claim 3, in which the mixers having a limited number of channels comprise mixers with two channels provided by means of semi-reflecting mirrors or dichroic reflectors.

5. A system as claimed in any preceding claim, further comprising means for successively generating a plurality of objects in the focal plane of the lens at a frequency such that successive interruptions cannot be perceived by the human eye.

6. A system as claimed in any proceding claim characterised in which the control of each of these light sources takes place by addressing.

7. A system as claimed in claim 5 or claim 6, further comprising a selector receiving digital signals from a calculator corresponding to several objects, and the selector successively transmits these signals to a transmission line having parallel conductors, which is connected to a de-coder for controlling the illumination of the light sources.

8. A system as claimed in any preceding claim, further comprising a device for increasing the dimensions of the image projected on a windscreen of an aircraft, said device comprising at least two parallel mirrors at least one of which is partially reflecting, and these mirrors are located in the light beam emitted by the lens such that the reflected beams are adjacent and the images formed on the windscreen by these beams are juxtaposed vertically or horizontally.

9. A system as claimed in claim 8, in which the system comprises a semi-reflecting mirror and a total reflection mirror, the semi-reflecting mirror being provided such that the transmitted intensity is slightly higher than the reflected intensity.

10. A system as claimed in any preceding claim, in which the system comprises a correcting device located between the member for forming an image and the lens for at least partially compensating the absence of parallelism of the light rays of the beam reflected by a/the windscreen of an aircraft, the correcting device comprising a lens of cylindrical shape.

11. A system according to any of claims 1 to 9 installed in an aircraft, in which the optical path from the outlet of said lens is in the region of the lower limit of the pilot's normal field of vision.

12. A system as claimed in claim 11, in the outlet of said lens is located is the region of the plane of the upper part of the dashboard.

13. A system for projecting images, substantially as hereinbefore described with reference to the accompanying drawings.

MARKS & CLERK,
7th Floor,
Scottish Life House,
Bridge Street,
Manchester, M3 3DP
Agents for the Applicants.

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Fig. 1

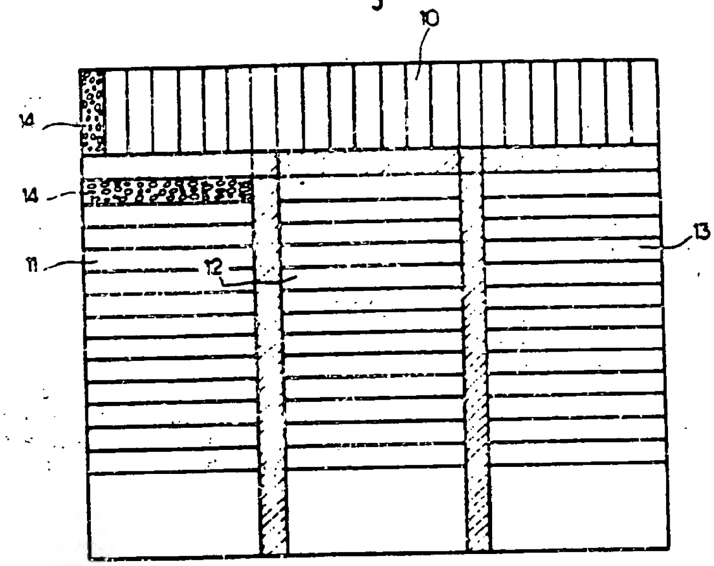
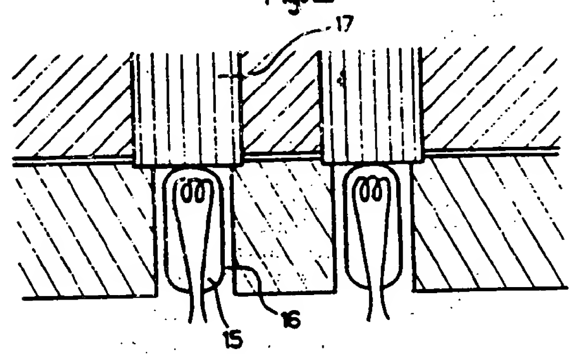


Fig. 2



1584573 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

Fig. 3

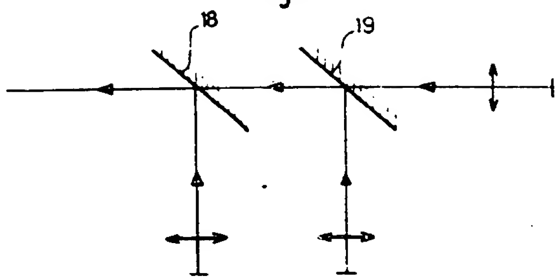
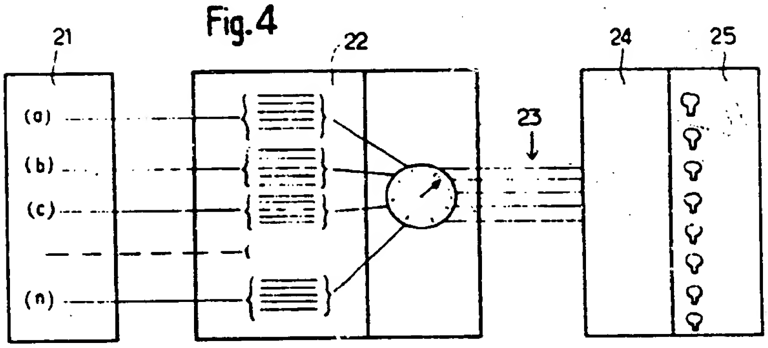


Fig. 4



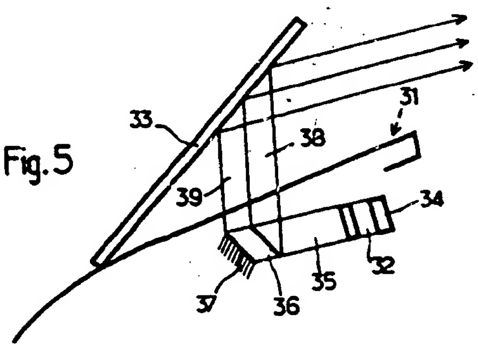


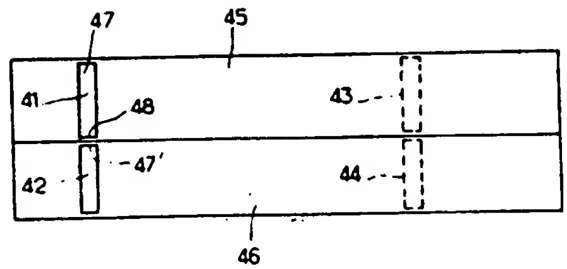
Fig. 5

1584573 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 3

Fig.6



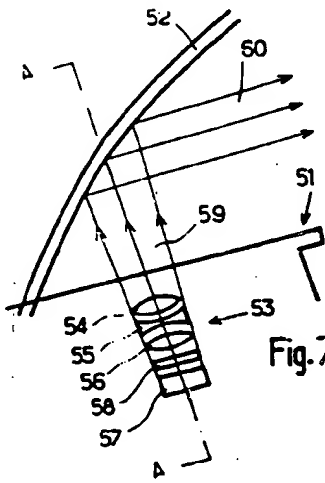


Fig.7

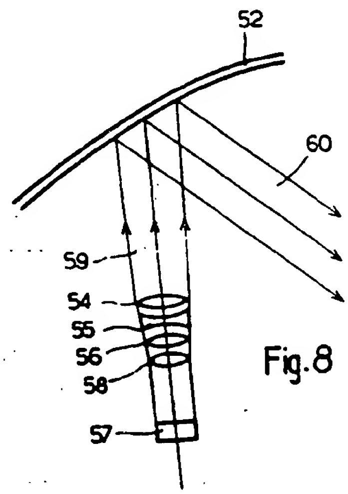


Fig.8

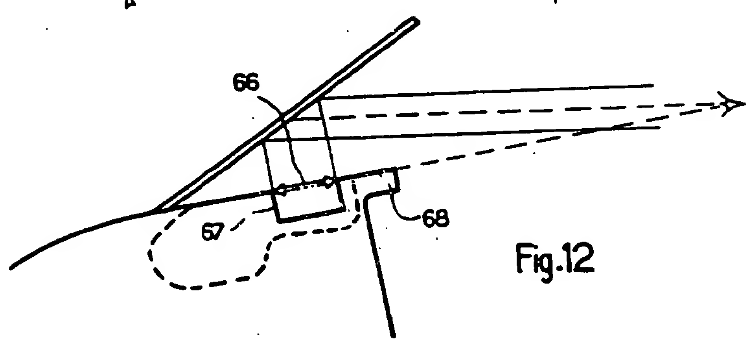


Fig.12

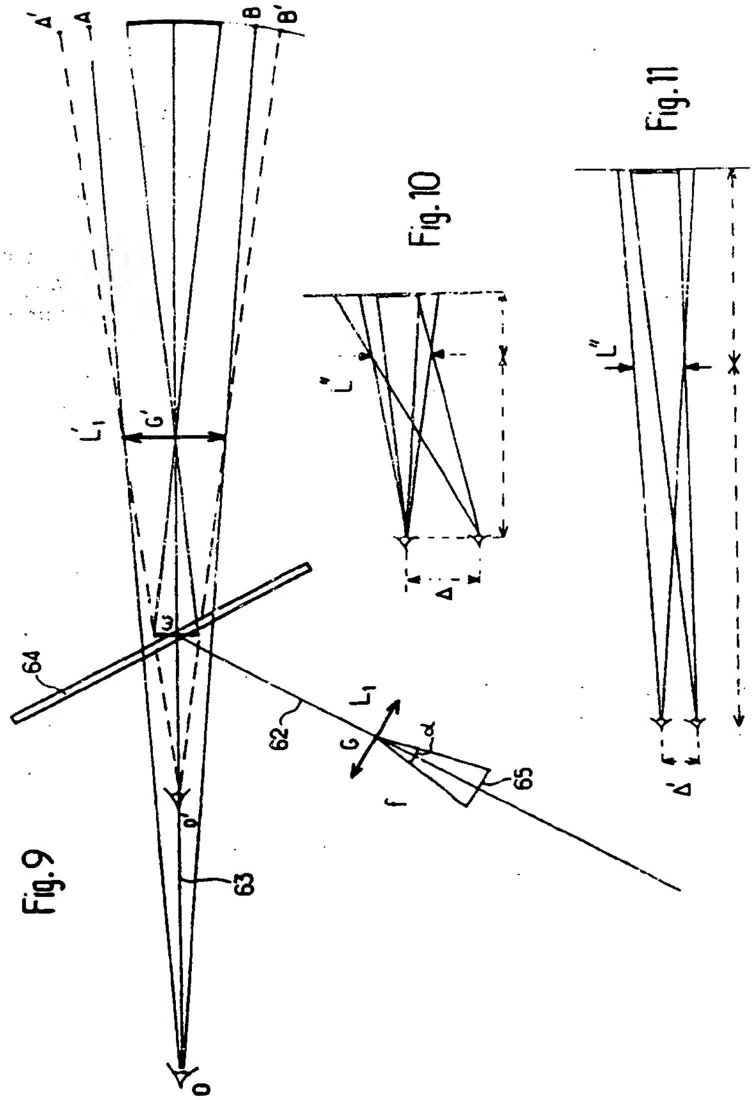


Fig.9

Fig.10

Fig.11